SPACE TRUSS

Technical Field

The present invention relates to a space truss to be used for skeletons of various structures.

Background Art

As the space truss of this kind, one shown in Figs. 12 and 13 has been conventionally known. The truss 50 is composed of a rectangular upper lattice 51 composed of chord members 53a and 53b in vertical directions and horizontal directions, respectively; a rectangular lower lattice 52 similarly composed of chord members 54a and 54b in vertical directions and horizontal directions, respectively; and diagonal members 57a and 57b mutually connecting each of intersection points 55 and 56 of the chord members in both of the lattices 51 and 52.

In such a space truss 50, many chord members 53a, 53b, 54a and 54b and diagonal members 57a and 57b must be combined to intersect with one another, and they must be coupled to one another at the intersection points 55 and 56 for fabricating the space truss 50. Consequently, not only the handling of each member such as the management and the transport of them is troublesome, but also the coupling work of the members needs much trouble. Consequently, it has been desired to decrease the number of members as much as possible, or to simplify the coupling work.

However, because the chord members 53a, 53b, 54a and 54b in the vertical directions and the horizontal directions and the diagonal members 57a and 57b are formed by coupling short rod members 58 and 59 divided between each intersection point generally in the known space truss mentioned above, the

number of the members is very large, and the handling and the assembling work of them are very troublesome.

If the chord members 53a, 53b, 54a and 54b and the diagonal members 57a and 57b are formed by rod members having the lengths equal to the sizes of the respective lattices 51 and 52, the number of the members can be reduced, but the lengths of respective members become longer, which makes the manufacturing, the custody, the transport and the like of the members difficult on the contrary.

Though it can be considered to use rod members having intermediate lengths covering a plurality of intersection points, at some lengths of the rod members, three to four kinds of rod members having different lengths from one another are necessary at the time of coupling a plurality of rod members by combining them in the vertical directions and in the horizontal directions in accordance with the size of a truss, especially in the case where the vertical size and the horizontal size of the truss is different from each other. Moreover, in some cases, because the numbers of members to be mutually coupled at each intersection point are different from one another, parts to be used such as washers and spacers are also different from one another. Consequently, the management of parts and connection work are troublesome.

It is a technical problem of the present invention to decrease the number and the kinds of rod members to be used to make their handling easy, and to simplify the fabrication work of a truss, by forming chord members in the vertical directions and the horizontal directions constituting an upper lattice and a lower lattice of a space truss, and diagonal members coupling both the lattices by forming the chord members and the diagonal members by coupling rod members each having a specific length and a specific shape to be commonly used.

Disclosure of the Invention

For solving the problem, a space truss of the present invention is composed of a rectangular upper lattice and a rectangular lower lattice, each composed of chord members in vertical directions and in horizontal directions, the chord members intersecting with each other, and diagonal members coupling intersection points of the chord members in both of the lattices mutually. The chord members in the vertical directions and in the horizontal directions in both of the lattices are formed by using long rod members formed to have a length twice as long as a distance between the intersecting points, the long rod members including coupling portions at both ends and at centers of the rod members, as main members, and by arranging a plurality of long rod members in the vertical directions and the horizontal directions, and by coupling ends of long rod members intersecting with a long rod member to a center of the latter long rod member at each of the intersection points, and by coupling a short rod member with an end of a chord member at which the length of the long rod members is too long in place of the long rod member, the short rod member formed to have a length equal to the distance between the intersection points, the short rod member including coupling portions at both ends thereof. Moreover, the diagonal members are formed by using bent rod members shaped in a letter V, the bent rod members having coupling portions at both ends and at centers of the rod members, as main members, and by arranging a plurality of bent rod members in a state of intersecting to each other and of intersecting with the chord members of both of the lattices diagonally at positions of the respective intersecting points, and by coupling ends of bent rod members intersecting with a bent rod member to a center of the latter bent rod member at each of the intersection points, and by coupling a straight line rod member with an end of a diagonal

member at which the length of the bent rod members is too long in place of the bent rod member, the straight line rod member formed to have a length equal to one side of the letter V of the bent rod members, the straight line rod member including coupling portions at both ends thereof.

The space truss of the present invention including the above-mentioned configuration is configured as follows. That is to say, the chord members in the vertical directions and in the horizontal directions constituting the upper lattice and the lower lattice use the long rod members having the length twice as long as the distance between intersection points as main members, and the long rod members are coupled in order in a specific pattern. Moreover, the above-mentioned diagonal members uses the bent rod members shaped in the letter V as the main members, and the bent rod members are coupled in order in a specific pattern. Consequently, the number and the kinds of the rod members to be used are few, and the handling of them is easy. Moreover, because each rod member can be coupled in order in a fixed pattern, the fabrication work of the truss and the like can be also simplified.

In the present invention, the coupling portion at the center and the coupling portions at ends of each of the rod members are severally formed by flattening parts of the rod member.

According to a concrete configuration embodiment of the present invention, the coupling portions at the centers and the coupling portions at the ends mutually have the same size, and the coupling portions of each of the rod members of the chord members in the vertical direction and in the horizontal direction and the diagonal members are laid on tops of others directly or with a spacer at each intersection points of both of the lattices, and the chord members and the diagonal members are coupled with one another by being fastened with

bolts and nuts with washers arranged on both the sides of the coupling portions.

According to another concrete configuration embodiment, sizes of the coupling portions of the ends of each of the rod members are a half of a size of the coupling portion at the center of the rod member, and a reinforcing member is integrally provided on one side of each of the coupling portions, the reinforcing member also functioning as a spacer, and coupling portions of ends of two rod members of the chord members in the vertical directions and in the horizontal directions and the diagonal members, the two rod members intersecting with a rod member, are directly laid on the top of the coupling portion at a center of the latter rod member in a state of being placed opposite to each other at each of the intersection points of both of the lattices, and each of the coupling members are mutually coupled by being fastened by a plurality of bolts and nuts with washers disposed on both sides of the coupling members.

In the present invention, at each of inside intersection points except intersection points positioned at periphery portions of both of the lattices among each of the intersection points at which the chord members and the diagonal members are coupled to one another, a coupling numbers of the rod members of the chord members and the diagonal members are severally three, and the chord members and the diagonal members are mutually coupled at each of the intersection points in the inside by the same coupling structure.

Thereby, because the above-mentioned chord members and the diagonal members can be coupled at each intersection point by using the same parts and by the same method, the fabrication of the truss becomes simpler.

Brief Description of Drawings

Fig. 1 is a plan view schematically showing an embodiment of a space truss according to the present invention in a form of emphasizing an upper lattice and a lower lattice.

Fig. 2 is a plan view schematically showing the embodiment of the space truss according to the present invention in a form of emphasizing diagonal members.

Fig. 3 is a schematic side view of the space truss.

Fig. 4(A) is a plan view of a long rod member constituting a chord member of the space truss of the present invention, and Fig. 4(B) is a plan view of a short rod member of the same space truss.

Fig. 5 is a partial plan view showing the configuration embodiment of chord members in the upper lattice in a disassembled state.

Fig. 6(A) is a side view of a bent rod member constituting a diagonal member in the space truss of the present invention, and Fig. 6(B) is a side view of a straight line rod member of the same space truss.

Fig. 7 is a partial plan view showing the configuration embodiment of diagonal members in a disassembled state.

Fig. 8 is a plan view of a principal part typically showing a coupling structure of the chord members and the diagonal members in the space truss of the present invention with regard to an intersection point of the upper lattice.

Fig. 9 is a sectional view made up by synthesizing the cross section of the chord members at the position of an A-A line in Fig. 8 and the cross section at the position of a B-B line.

Fig. 10 is a sectional view of a principal part typically showing a second embodiment of the coupling structure of the chord members and the diagonal members in the space truss of the present invention with regard to an intersection point of the upper lattice at a cross section

position similar to that of Fig. 9.

Fig. 11 is an exploded perspective view of Fig. 10.

Fig. 12 is a plan view showing the whole configuration of a conventional space truss.

Fig. 13 is a side view of the same space truss.

Best Mode for Carrying Out the Invention

In the following, embodiments of the present invention are described in detail on the basis of the drawings. Figs. 1-3 schematically show an embodiment of a space truss according to the present invention. The space truss 1 has a basic form common to that of the conventional truss 50 shown in Figs. 12 and 13. The space truss 1 is composed of a rectangular upper lattice 2 composed of chord members 2a and 2b in vertical directions and in horizontal directions, which intersect with each other; a rectangular lower lattice 3 similarly composed of chord members 3a and 3b in vertical directions and in horizontal directions; and diagonal members 4a and 4b mutually connecting intersection points 5 of the chord members 2a and 2b in the upper lattice 2 and intersection points 6 of the chord members 3a and 3b in the lower lattice 3. However, the space truss 1 differs from the conventional truss 50 mentioned above in the configurations with regard to the chord members 2a, 2b, 3a and 3b and the diagonal members 4a and 4b mentioned above as will be described in the following.

Incidentally, for simplifying the drawings, in Fig. 1, the chord members 2a, 2b, 3a and 3b in the upper lattice 2 and the lower lattice 3 in the vertical directions and in the horizontal directions are exhibited by means of solid lines having different thicknesses from each other, and the diagonal lines 4a and 4b are exhibited by means of chain lines. Thereby, the upper lattice 2 and the lower lattice 3 are emphasized. In Fig. 2, the diagonal lines 4a and 4b are

exhibited by solid lines, and the upper lattice 2 and the lower lattice 3 are exhibited by chain lines and dotted lines, respectively. Thereby, the diagonal lines 4a and 4b are emphasized.

The chord lines 2a, 2b, 3a and 3b in the vertical directions and in the horizontal directions in the upper lattice 2 and in the lower lattice 3 mentioned above are each formed of a long rod member 8, which has a length twice as long as a distance L between intersection points 5, as a main material, as shown in Fig. 4(A). A short rod member 9 having a length equal to the distance L between the intersection points is used at an ends of parts of the chord members, as shown in Fig. 4(B). Any of the long rod member 8 and the short rod member 9 is composed of a pipe member made of a metal having a cross section of a circle or a square shape. In case of the long rod member 8, the long rod member 8 includes flattened rectangular coupling portions 8a and 8b at both the ends and the center thereof. In case of the short rod member 9, the short rod member 9 includes flattened rectangular coupling portions 9a at both the ends thereof. Each of the coupling portions 8a, 8b and 9a has the same size to one another. Moreover, a reference numeral 12 in the drawings denotes a bolt hole formed in each of the coupling members 8a, 8b and 9a mentioned above. Then, the upper lattice 2 and the lower lattice 3 mentioned above are configured by means of these long rod members 8 and the short rod members 9 as follows. Incidentally, both of these lattices 2 and 3 are different from each other only in their sizes and their configurations are basically the same. Consequently, the configurations of them are described by exemplifying the above-mentioned lattice 2.

That is to say, as shown in Fig. 5 in a magnified manner, the chord members 2a and 2b in the vertical directions and in the horizontal directions in the upper

lattice 2 are formed by arranging the above-mentioned long rod members 8 in the vertical directions and in the horizontal directions to couple them in order. At that time, the disposition positions of the long rod members 8 in adjacent chord members in either group of the chord members 2a or 2b are mutually shifted by the half lengths of the long rod members 8, i.e. by the distance L between intersection points, in axial line directions, and thereby the coupling portions 8a of the ends of the long rod members 8 intersecting with a long rod member 8 are severally coupled to the central coupling portion 8b of the long rod member 8. The coupling pattern is repeated. Then, as shown in Fig. 1, when the length of the above-mentioned long rod member 8 is too long in case of coupling the long rod member 8 to the end of a chord member, the short rod member 9 is coupled to the end of the chord member in place of the long rod member 8. By connecting the long rod members 8 and the short rod members 9 in such a pattern in order, the rectangular upper lattice 2 is formed. Also the lower lattice 3 is similarly formed.

Moreover, the above-mentioned diagonal members 4a and 4b are formed of bent rod members 10 bent in the shape of a letter V as shown in Fig. 6(A) as main members. A straight line rod member 11 formed to have the same length as that of one side of the letter V of the above-mentioned bent rod member 10, as shown in Fig. 6(B), is used to the ends of parts of the diagonal members. Both of the bent rod member 10 and the straight line rod member 11, mentioned above, are made of a metal pipe member. In case of the bent rod member 10, the rod member 10 includes flatted rectangular coupling portions 10a, 10b at the both ends and the center of the rod member 10. In case of the straight line rod member 11, the rod member 11 includes flatted rectangular coupling portions 11a at both the ends thereof. Each of these coupling

portions 10a, 10b and 11a has the same size as that of each of the coupling portions 8a, 8b and 9a of the long rod member 8 and the short rod member 9 mentioned above.

Then, as it is clear from Figs. 2 and 7, a plurality of bent rod members 10 is arranged in order to be intersected with one another, and in order to be obliquely intersected at the respective intersection points 5 and 6 with the chord members 2a, 2b, 3a and 3b of both the lattices 2 and 3 in the vertical directions and in the horizontal directions. Then, the coupling portions 10a at the ends of the bent rod members 10 intersecting with a bent rod member 10 are severally coupled to the coupling portion 8b at the center of the bent rod member 10. Moreover, when the length of the above-mentioned bent rod member 10 is too long in case of coupling the bent rod member 10 to the ends of the diagonal members, the above-mentioned straight line rod number 11 is coupled with the ends of the diagonal members 4a or 4b in place of the bent rod member 10. A reference numeral 13 in Fig. 6 denotes a bolt hole formed in each of the coupling portions 10a, 10b and 11a.

The above-mentioned bent rod members 10 are severally arranged in the state of an inverted letter V with the coupling portions 10b at the centers being upward, and the coupling portions 10b at the centers are coupled to the intersection points 5 of the chord members 2a and 2b of the upper lattice 2, and further the coupling portions 10a on both ends are coupled to the intersection points 6 of the chord members 3a and 3b of the lower lattice 3 in the diagonal members 4a sloping upward when going from left to right in the drawings. On the other hand, in the diagonal members 4b sloping downward when going from left to right, the above-mentioned bent rod members 10 are severally arranged in the state of a letter V with the coupling portions 10b at the centers being downward, and the coupling

portions 10b at the centers are coupled to the intersection points 6 of the chord members 3a and 3b of the lower lattice 3, and further the coupling portions 10a on both ends are coupled to the intersection points 5 of the chord members 2a and 2b of the upper lattice 2.

Each of the above-mentioned rod members 8, 9, 10 and 11 constituting each of the chord members 2a, 2b, 3a and 3b and each of the diagonal members 4a and 4b is integrally coupled at each of the above-mentioned intersection points 5 and 6 of the chord members 2a, 2b, 3a and 3b. Figs. 8 and 9 typically show the coupling structure of the chord members 2a and 2b in the vertical direction and in the horizontal direction in the upper lattice 2 with the diagonal members 4a and 4b at one intersection point 5 of the chord members 2a and 2b. The intersection point 5 is one of the intersection points 5 except the intersection points 5a positioned on the periphery portion of the upper lattice 2 (see Fig. 1) to be positioned in the inside of the intersection points 5a. At each of the intersection points 5 positioned in the inside of the lattice, the chord members 2a and 2b in the vertical direction and in the horizontal direction and the diagonal members 4a and 4b are mutually coupled in the same coupling structure. That is to say, the coupling portion 8b at the center of the long rod member 8 constituting the chord member 2a in one direction and the coupling portions 8a of the ends of the chord members 2b intersecting with the above-mentioned long rod member 8 are mutually laid on the top of another, and the coupling portion 10b at the center of the bent rod member 10 constituting the diagonal member 4a in one direction and the coupling portions 10a at the ends of the bent rod members 10 constituting the diagonal members 4b intersecting with the above-mentioned diagonal member 4a are mutually laid on the top of another with spacers 14a and 14b put between them at the laying portion. The laying portion is fixed with a bolt

16 and a nut 17 with putting washers 15 disposed on both ends of the laying portion between.

Incidentally, in Fig. 9, a state in which the cross section taken along an A-A line in Fig. 8 with regard to the intersection portion of the chord members 2a and 2b in the vertical direction and in the horizontal direction is shown, and a state in which the cross section taken along a B-B line in Fig. 8 with regard to the intersection portion of the diagonal members 4a and 4b is shown.

As described above, at each of the above-mentioned intersection portions 5 positions in the inside of the upper lattice 2, the number of the mutually coupled rod members 8 and 9 of the chord members 2a and 2b in the vertical direction and in the horizontal direction and the number of the mutually coupled rod members 10 and 11 of the diagonal members 4a and 4b are severally three, i.e. all are the same number. Consequently, the respective members can be coupled in the same coupling structure using the common spacers 14a and 14b, the washer 15, the bolt 16, the nut 17 and the like, and thereby the management of parts, coupling work and the like are very simple. The advantage can be achieved by coupling each of the above-mentioned rod members 8 and 10 constituting the chord members 2a and 2b in the vertical directions and in the horizontal directions and the diagonal members 4a and 4b in the above-mentioned peculiar pattern. This situation is quite the same also in the intersection points 6 in the inside of the lower lattice 3.

On the other hand, at the intersection points 5a and 6a positioned on the periphery portions of the lattices 2 and 3, the number of the coupled rod members 8, 9, 10 and 11 is fewer than that of the above-mentioned intersection points 5 and 6 in the inside, but the rod members 8-11 can be mutually coupled by means of the same spacers 14a and 14b, the washers 15, the bolts 16, the nuts 17 and the like.

Incidentally, the coupling structure of the intersection points 5 and 6 is not limited to the above-mentioned example, but the other coupling structures can be used. For example, each of the coupling portions 8a, 8b, 9a, 10a, 10b and 11a of the rod members 8, 9, 10 and 11 may be directly laid on the top of another by omitting the above-mentioned spacer 14. Alternatively, a coupling structure of a second embodiment as shown in Figs. 10 and 11 can be also used.

Figs. 10 and 11 typically show the second embodiment of the coupling structure of the chord members 2a and 2b and the rod members 4a and 4b with regard to one intersection point 5 positioned in the inside of the upper lattice 2 similarly in the case shown in Figs. 8 and 9. In the second embodiment, the coupling portions 8a and 10a at the ends of the respective rod members 8 and 10 are formed to be a half size of those of the coupling portions 8b and 10b at the centers, and thick reinforcing members 20a, 20b, 21a and 21 serving also as spacers are integrally formed on one side of each of the coupling portions 8a, 8b, 10a and 10b, respectively. The reinforcing members 20a, 20b, 21a and 21 have substantially the same shape and the same size of the coupling portion to which the reinforcing members 20a, 20b, 21a and 21 are attached, and can be formed by fixing metal plates by welding or the like. Moreover, four bolt holes 12 are severally formed at corresponding positions in the coupling portions 8b and 10b at the center of the long rod member 8a and the bent rod member 10. Two bolt holes 12 are formed in each of the coupling portions 8a at the ends of the long rod member 8. On the other hand, in the coupling portions 10a at the ends of the bent rod member 10, one bolt hole 12 is formed at the center of each of the coupling portions 10a, and half holes 12a are severally formed on both the ends of the coupling portions 10a. Then, a bolt hole 12 is formed by two half

holes 12a standing opposite each other of both the coupling portions 10a when the coupling portions 10a of two bent rod members 10a are placed opposite to each other.

Then, the coupling portions 8a at the ends of the two long rod members 8 forming the chord members 2b intersecting with a chord member 2a in one direction are directly laid on the top of the coupling portion 8b at the center of the long rod member 8 constituting the chord member 2a in the one direction by abutting the mutual back faces, where the reinforcing members 20a and 20b are not formed, against each other in the state of placing the edges of the coupling portions 8a opposite to each other. Moreover, the coupling portions 10a at the ends of the two bent rod members 10 forming the diagonal members 4b intersecting with a diagonal member 4a in one direction are directly laid on the top of the coupling portion 10b at the center of the bent rod member 10 constituting the diagonal member 4a in the one direction by abutting the mutual back faces, where the reinforcing members 21a and 21b are not formed, against each other in the state of placing the edges of the coupling portions 10a opposite to each other. Furthermore, each coupling portion of the chord members 2a and 2b and the diagonal members 4a and 4b is mutually laid on the top of another in the state of abutting the reinforcing members 20a and 21a against each other, and each of the coupling portions is fastened with four bolts 16 and four nuts 17 with the washers 15 disposed on both the sides of the coupling portions between. Thereby the coupling portions are mutually coupled.

Incidentally, in the second embodiment, although it is not specially shown, the coupling portions 9a and 11a at the ends of the short rod member 9 and the straight line rod member 11 are also formed in the same sizes as those of the coupling portions 8a and 10a of the long rod member 8 and the bent rod member 10, and the reinforcing members 20a and 21a

are integrally formed on respective coupling portions. Moreover, in the case where no coupling portions to be placed opposite to each other exist because the number of the rod members to be coupled is few at the intersecting points 5a positioned on the periphery portion of the above-mentioned lattice 2, a spacer having the thickness same as that of the coupling portion is independently set at that portion to be coupled by a method similar to that of Fig. 9.

The coupling structures of the intersection points in the above-mentioned second embodiment are quite the same as those of the lower lattice 3.

Thus the space truss 1 configures the chord members 2a, 2b, 3a and 3b in the vertical directions and in the horizontal directions, which chord members constitute the upper lattice 2 and the lower lattice 3, by coupling the long rod members 8 having the length twice as long as the distance L between intersection points as main members in order in a specific pattern, and configures the diagonal members 4a and 4b coupling both the lattices 2 and 3 by coupling the bent rod members 10 shaped in the letter V as main members in order in a specific pattern. Consequently, the number of the rod members to be used is decreased to almost a half of the number of the rod members of the conventional truss formed by using short rod members divided to each intersection interval, and then the handling of the rod members is easy. Moreover, because each rod member can be connected in order in a fixed pattern, the assembling work and the like of the truss 1 are also simplified. Because the coupling number of the rod members and the coupling structures at each intersection points 5 and 6 are made to be common and the parts such as the reinforcing members, the washers, the bolts and the nuts are also made to be common as well, the assembling work and the like of the truss become further easier, and the management of the parts to be used also is easy.

The above-mentioned truss 1 can be formed in a plane shape by forming the chord members 2a, 2b, 3a and 3b in the vertical directions and in the horizontal directions severally by using the straight line long rod members 8 and the short rod members 9, and the truss 1 can be formed in an arch shape by forming either the chord members 2a, 3a or 2b, 3b in the vertical directions or in the horizontal directions by using the long rod members 8a and the short rod members 9, both bent in arches.

Industrial Applicability

As described above, according to the space truss of the present invention, chord members in the vertical directions and in the horizontal directions constituting the upper lattice and the lower lattice, and the diagonal members coupling these chord members are formed by coupling rod members which have specific lengths and specific shapes to be used in common. Thereby, the present invention is fitted to decrease the number and the kinds of the members to be used for making it easy to handle the members, and to simplify the fabricating work and the like of the truss.